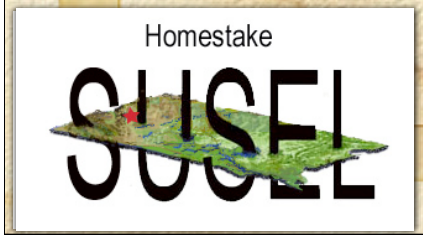
Update on DUSEL

(with a little Homestake Progress thrown in, such as what is all this about $70M)

Kevin T. Lesko
for the Collaboration
U.C. Berkeley and Berkeley Lab
16 September 2006



Outline of Today's Presentation

- NSF Process and Progress
- Sanford Gift - what it is, how it can be used, what is the timing of the gift, what are the triggers, *etc*.

New NSF Process: Act 1: March 2004 in DC, *in which*

- Original Turner DUSEL Process is Defined
  - Scene-1: site-independent science case for DUSEL
    - Sadoulet leading this performance - Draft report out
  - Scene-2: site dependent projection on different sites (Conceptual Design Report)
    - Homestake and Henderson selected (appealed by a site)
  - Scene-3: Technical Design Report solicitation *by invitation*
    - Funding in *FY09* for DUSEL construction

Act II: Recent Perturbations: June 2006, *in which*

- There is an appeal ⇒ NS grants 3rd Cooperative Agreement
- Process delayed ~ 1 year to complete additional CDR
- "Nothing wrong" with the panel selection or process
  - Upon inspection files were found to be incomplete
  - Comment about the PO's conduct and judgement
- Appealing site announces that they will concentration on a site that was not their *original primary focus, but was mentioned in their proposal*
- S-3 is to be open to all potential sites

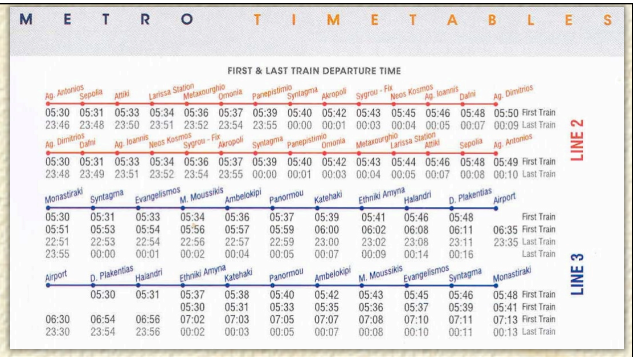
KTL's observations

Act III: More Perturbations, June 2006, *in which*

- NSF announces that the intention to focus on the *secondary* site was too different from original proposal, declines the S-2 funding.
- NSF announces a new time table
- S-3 still open to any site
- Intention to fund DUSEL in FY10
- NSF R&D funds in FY07 for Physics and Engineering

KTL's observations

New NSF Timetable



- **August 06** non-competitive review of two CDRs ⇒

  comments to the teams about CDR strengths and weaknesses by an anonymous panel, prepare for NSB, …

- **September 06** S-3 solicitation to be announced, funds to be provided to develop Technical Design Report (TDR), this will be the basis for arguments and case for DUSEL in the subsequent national review proposes

- **December 06** Responses to Solicitation due at NSF

- **February 07** Review of responses including site visits and reverse site visits, siting selection made

NSF Timetable *continued*

- **~ April 07** funding for TDR, winning team to develop more advanced plan for DUSEL (old "S-3")
- **Spring/Summer 07** Call for **Initial Suite Experiments** by NSF (iterative process)
- **~ October 07** baselined DUSEL plan ready for NSF review
- **~ March 08** presentation to NSF, National Science Board, …
- **FY10 DUSEL funding**, to include Experiments and Facility
  - Recent NSF Statements: Experiments > 50% of the ~$500M MRE

NSF's Physics R&D Solicitation

* * * NSF Preparing to Fund Underground R&D in FY07 * * *

Contingent on appropriate budget allocations and NSF approval, the NSF Physics Division is preparing to allocate funds in FY07 for detector-related R&D for underground, DUSEL-related physics experiments and related applications. For more information, see the url's below, which contain (1) a description of the NSF Particle and Nuclear Astrophysics program, and (2) a presentation given by the NSF DUSEL Program Manager for Physics, Jon Kotcher, during a recent visit to the two candidate underground sites.

Deadline for proposals will be September 2006. More information will be distributed as it becomes available.

(1) http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5633&org=PHY

(2) see slides 14 & 15 at
http://neutrino.lbl.gov/Homestake/NSF_site_visit/NSF_site_visit.pdf
or
http://nngroup.physics.sunysb.edu/husep/KotcherDUSELOverviewMar06Sites.pdf

Apply to PD 06-1643 in FastLane. (standard Grant Proposal Guidelines apply.)

DUE DATES

Full Proposal Target Date: September 27, 2006
Physics Target Date

It is recommended that proposals come in near the general Physics Division target date.

SYNOPSIS

Supports university research in particle and nuclear astrophysics, including experiments or research and design projects in underground facilities. Current supported activities are high-energy cosmic ray studies, solar and high-energy neutrino astrophysics, the study of gamma ray bursts, and searches for dark matter. Funding is also provided for accelerator-based nuclear astrophysics studies of stellar processes, nucleosynthesis, and processes related to cosmology and the early universe.

See additional information

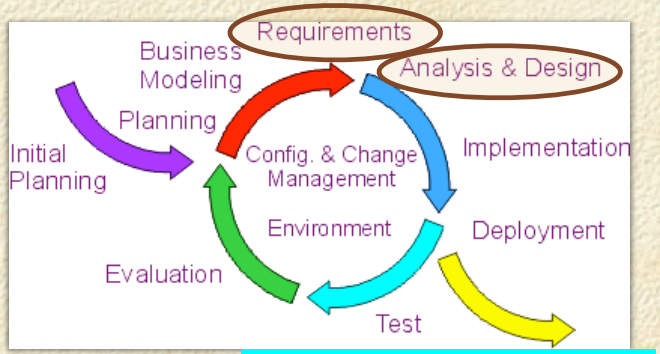
Abstracts of Recent Awards Made Through This Program

Engineering Call for Proposal as well

Homestake Strategies: 4850-lab Ų DUSEL

- **Homestake Collaboration** Developing the NSF solicitation process responses: S-1, S-2 (CDR), *S-3 (TDR)*, establishing scientific roadmaps and expanding the network of potential users and uses.

- **South Dakota Science and Technology Authority** (SDSTA) working with South Dakota resources to preserve Homestake for DUSEL and establishing an interim laboratory option with state controlled funding, developed conversion plan to preserve Homestake
  - title
  - access and water
  - preserve site and open it in advance of DUSEL



Initial Uses in 2007

Expanded Uses in 2010 as DUSEL

Early Implementation Program

- Foremost purpose was to preserve Homestake for DUSEL
- Taking advantage of State funded laboratory: 2007 - 2012
- **300 L**, **4850 L**, and other levels, e.g. 2000 L, 3800 L
- Ross and Yates Shafts refurbished, safe and operating
- Basic operations, including Safety, Utilities, Services
- Upgrades and enhancements as budget permits
- International Call for Letters of Interest
- Established **Program Advisory Committee in 2005**
  - Charge was to consider the Early Implementation Program, but to be aware of longer term aspects and uses
  - Decision factored in the 5 criteria, National "issues" and Homestake "capacity"

Progress at Homestake

- [x] October 2005, State Legislature approves additional $20M funding for Homestake, total of $46M from state controlled sources.
  Rehab plan: $15M, Indemnification fund: $10M, Operations: $15M (initialization + 5 years of EIP), Contingency: $3.5M, Insurance: $2.5M
- [x] 1 November 2005 - First call for Letters of Interest for Homestake - 85 letters received by February 2006
- [x] Property Donation Agreement Completed 14 April 2006, Property formally transfers to S.D. 12 May 2006, SDSTA hiring staff to oversee and operate Homestake (mine engineers, safety, PM, etc.)
- [ ] Early Implementation Program at Homestake 2008 - 2012, with SD funds being defined

Progress at Homestake

- Transfer of site accomplished Barrick ⇒ SDSTA May 2006
- SDSTA moved to Homestake, remodeled upper floor of the Admin building May 2006
- Conceptual Design Report submitted June 2006
- Renewed discussions about water-treatment and waste-rock disposal options in cooperation with Barrick's continued presence and remediation
- Site ribbon-cutting June 2006

Progress at Homestake

- ☑ June 2006 announced Sanford Gift to Homestake, $70M to establish the laboratory

- T. Denny Sanford, banker and Financier, operations of credit card and bank from S.D.

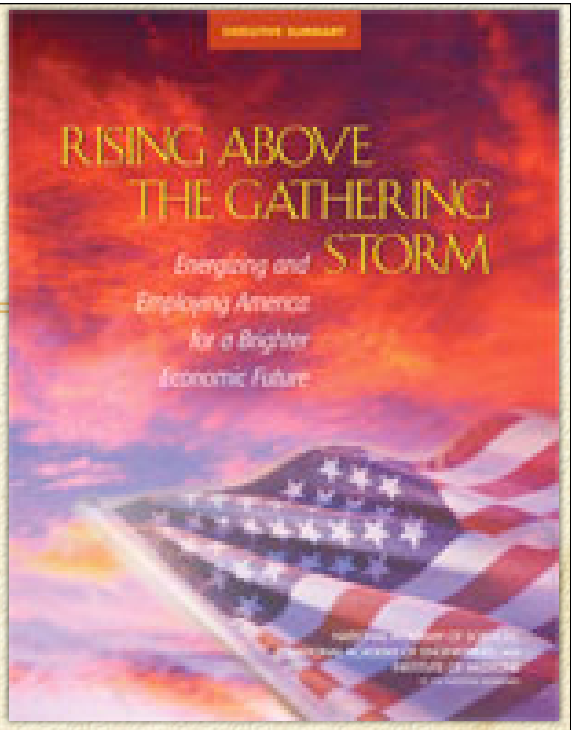
- History of donations to hospitals, universities, educational and children's causes

- Sets a new stage for private funding for science projects

Sanford Gift: $70M

- Gift 1: $35M to be made in two installments
  - Gift 1 Part 1: $15M by December 2007
  - Gift 1 Part 2: $20M by December 2008
- For 4850L laboratory and infrastructure
  - lifts, access, custom space, operations, surface space, radon-reduced air, ...

Sanford Gift: $70M



- Gift 2: $20M
  - $20M by December 2009
  - For Sanford Science Center (E&O)
- Gift 3: $15M
  - between January 2010 - December 2012
  - For going deep, 7400 level lab

Triggers for the Gift

- Gift 1 - $35M 2007 - 2008
  - NSF "selects" Homestake, sole candidate site for DUSEL
  - Laboratory is Named Sanford Underground Science and Engineering Laboratory (SUSEL-Homestake)
  - SDSTA spends their $ (rehabilitation and re-entry)
  - Significant scientific demand (defining users of EIP)
    - measured by MOUs, $10M

Triggers for the Gift

- Gift 2 - $20M 2009
  - Gift 1 triggers satisfied
  - naming rights - Sanford Science Center
  - SDSTA develops “business plan” and spends their $ on center
- Creates ~50,000 ft² education & outreach center

Triggers for the Gift

- Gift 3 - $15M 2010-2012
  - Gift 1 and 2 conditions satisfied
  - National funding for laboratory (NSF, DOE, etc.) to the tune of $15M
  - SDSTA spend their $

Uses for Gift 1

- Automation and modernization of Ross and Yates hoists to lower energy and operating costs
- Provide modern personnel hoist in Yates shaft
- Extend hours for working underground
- Create clean room space and underground laboratories
- Upgrade surface support facilities, such as those for materials receiving and component assembly and fabrication
- Provision of low radon air to the underground
- Develop additional common use areas underground for experiment support
- Additional infrastructure upgrades underground
- Excavate additional space as funds allow

The total amount of Mr. Sanford's funds to be used in Project No. 1 is $35,000,000. It is anticipated that SDSTA would also expend $15,000,000.00 of its own funds in connection with Project No. 1. Upon the completion of Project No. 1, the Sanford Underground Science and Engineering Laboratory at Homestake would be in a position to host scientific and engineering experiments at the 4,850 foot level with minimal additional infrastructure or construction work. At the completion of Project No. 1, the space at the 4,850 level would essentially be in a position to move in scientific experiments. Absent unforeseen circumstances, it is anticipated that Project No. 1 will be commenced in 2007 and completed in 2008.

Uses for Gift 2

- Hands-on science center featuring interactive exhibits
- Video/animation production facilities for educational programming
- Multimedia transmission capabilities for distance learning
- Construction of the Sanford Center for Science Education
- On-campus housing
- Conference facilities, including meeting rooms and a small theater
- Classrooms and laboratories

The Education Center would be known as the Sanford Center for Science Education. The Sanford Center for Science Education will include approximately 50,000 square feet of the building space. It is anticipated that $20,000,000.00 of Mr. Sanford's Gift No. 2 would be used for Project No. 2. In addition, the SDSTA anticipates spending approximately $1,500,000.00 of its own resources in support of Project No. 2. It is anticipated that approximately $3,000,000.00 of Mr. Sanford's Gift No. 2 will be utilized to support the operations of the Education Center through the year 2012. The operating support from Mr. Sanford's Gift No. 2 will not include funding for actual educational services, but may include funding to support utility and other occupancy and infrastructure expenses of the Education Center. Absent unforeseen circumstances, it is anticipated that Project No. 2 will be commenced in 2008 and completed in 2009.

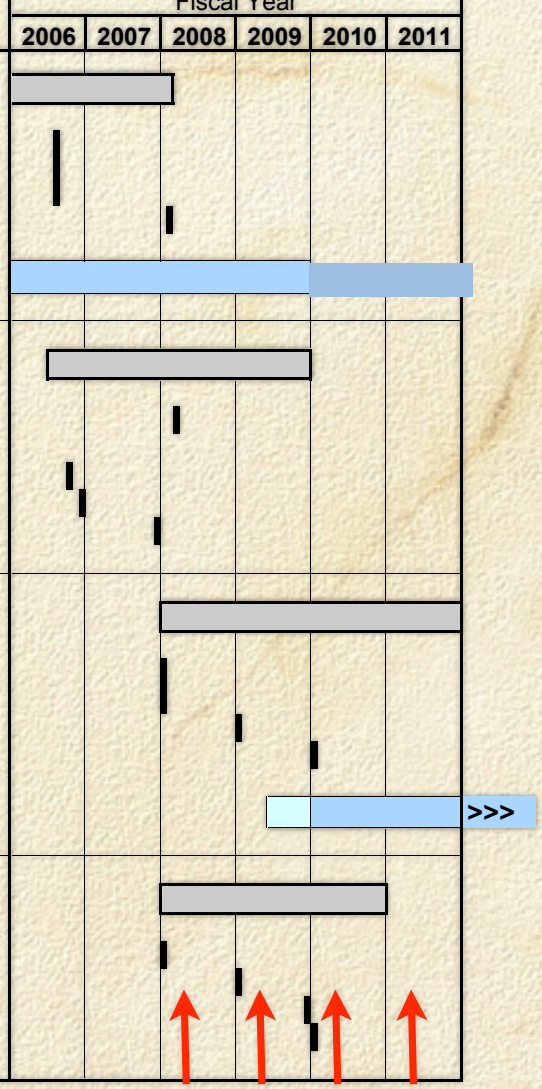
Uses for Gift 3

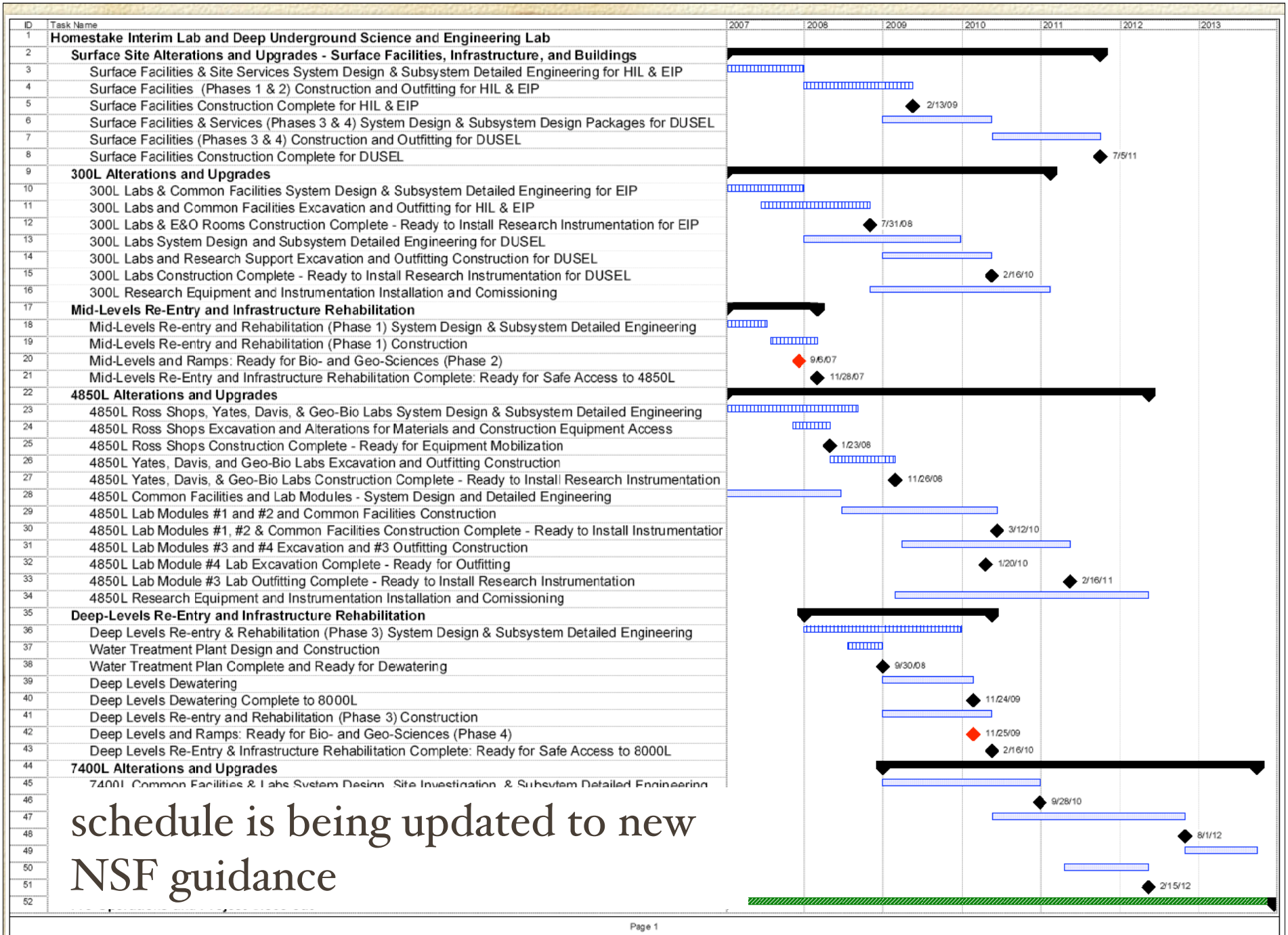
Project No. 3 would involve removing the accumulated pooled water in the mine to the 8,000 foot level and rebuilding the infrastructure in the mine down to the 7,400 foot level. This would make the Sanford Underground Science and Engineering Laboratory at Homestake accessible and experiment-ready at the 7,400 foot level, but would not include the creation of experiment or clean-room or other space at that level. Funding for the preparation of the actual laboratory space at the 7,400 foot level is anticipated to come from the National Science Foundation or other federal agencies. It is anticipated that $15,000,000 of Mr. Sanford's funds would be used in Project No. 3. The total anticipated cost for establishing appropriate laboratory and clean-room and other space at the 7,400 foot level is approximately $30,000,000.00. It is uncertain at this point whether Project No. 3 will ever be undertaken, but it is not likely to be commenced any time prior to 2010.

Management and Operation: Phased approach

Homestake DUSEL Project Timeline and Major Milestones for Laboratory Development and Initial Operations

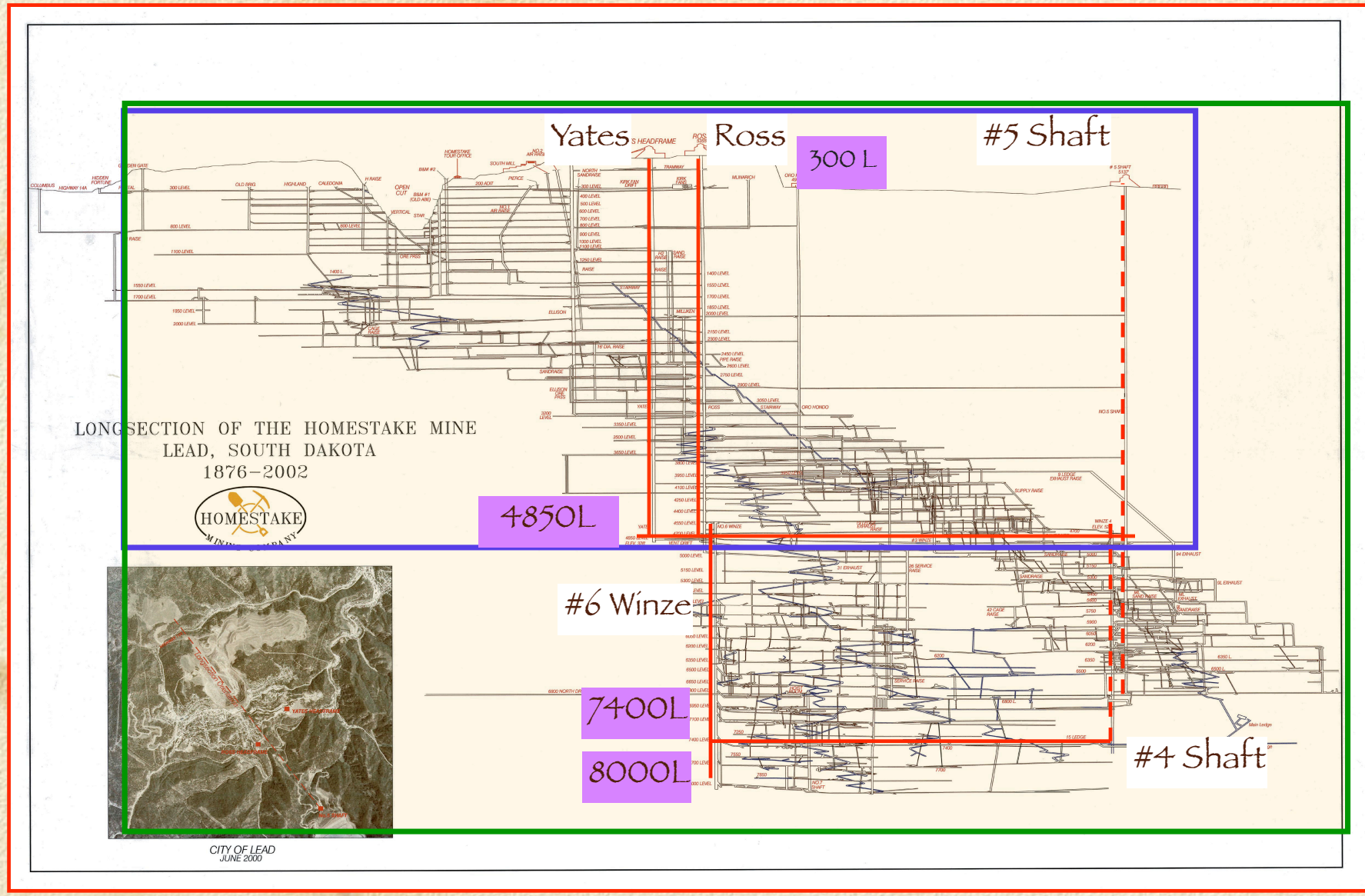
	Project Phases (Lead Organization)	Start
Homestake Interim Laboratory and EIP	**Phase 1: Mining-to-Labs Conversion and Re-entry to Mid-Levels (SDSTA)**	Oct-05
	Milestone: Homestake Ownership Transfer to SDSTA ✔	May-06
	Milestone: SDSTA Occupancy, Initiate Conversion Project Detailed Engineering ✔	May-06
	Milestone: Mid Levels Beneficial Occupancy for EIP early experiments	Nov-07
	Organization Chart: Homestake Lab Interim Management Organization (Figure 2.2)	
	Phase 2: Early Implementation Program (EIP) S&E Labs (UC Berkeley)	May-06
	Milestone: Ready to begin Construction & Outfitting for EIP early experiments	Dec-07
	Milestone: Submit Homestake DUSEL Conceptual Design Report (NSF S-2)	Jun-06
	Milestone: Homestake Site Selection for DUSEL	Sep-06
	Milestone: Submit Homestake DUSEL Preliminary Design Package (NSF S-3 TDR)	Sep-07
Homestake DUSEL	**Phase 3: DUSEL Re-entry and Access to Deep Levels (SDSTA)**	Oct-07
	Milestone: Begin DUSEL Facility & Systems Detailed Design (NSF Funding)	Oct-07
	Milestone: Begin Detailed Engineering for Deep Levels Re-entry and Dewatering	Oct-07
	Milestone: DUSEL Facility Infrastructure Construction Start	Oct-08
	Milestone: Homestake DUSEL Beneficial Occupancy	Oct-09
	Organization Chart: Homestake DUSEL Management Organization (Figure 2.3)	
	Phase 4: DUSEL Science and Engineering Program Development (UC Berkeley)	Oct-07
	Milestone: Begin R&D for Initial Suite of Experiments (ISE) (NSF Funding)	Oct-07
	Milestone: Begin DUSEL ISE Detailed Design	Oct-08
	Milestone: Submit Detailed Design Package for DUSEL ISE	Sep-09
	Milestone: Initiate Construction & Outfitting for DUSEL ISE	Oct-09

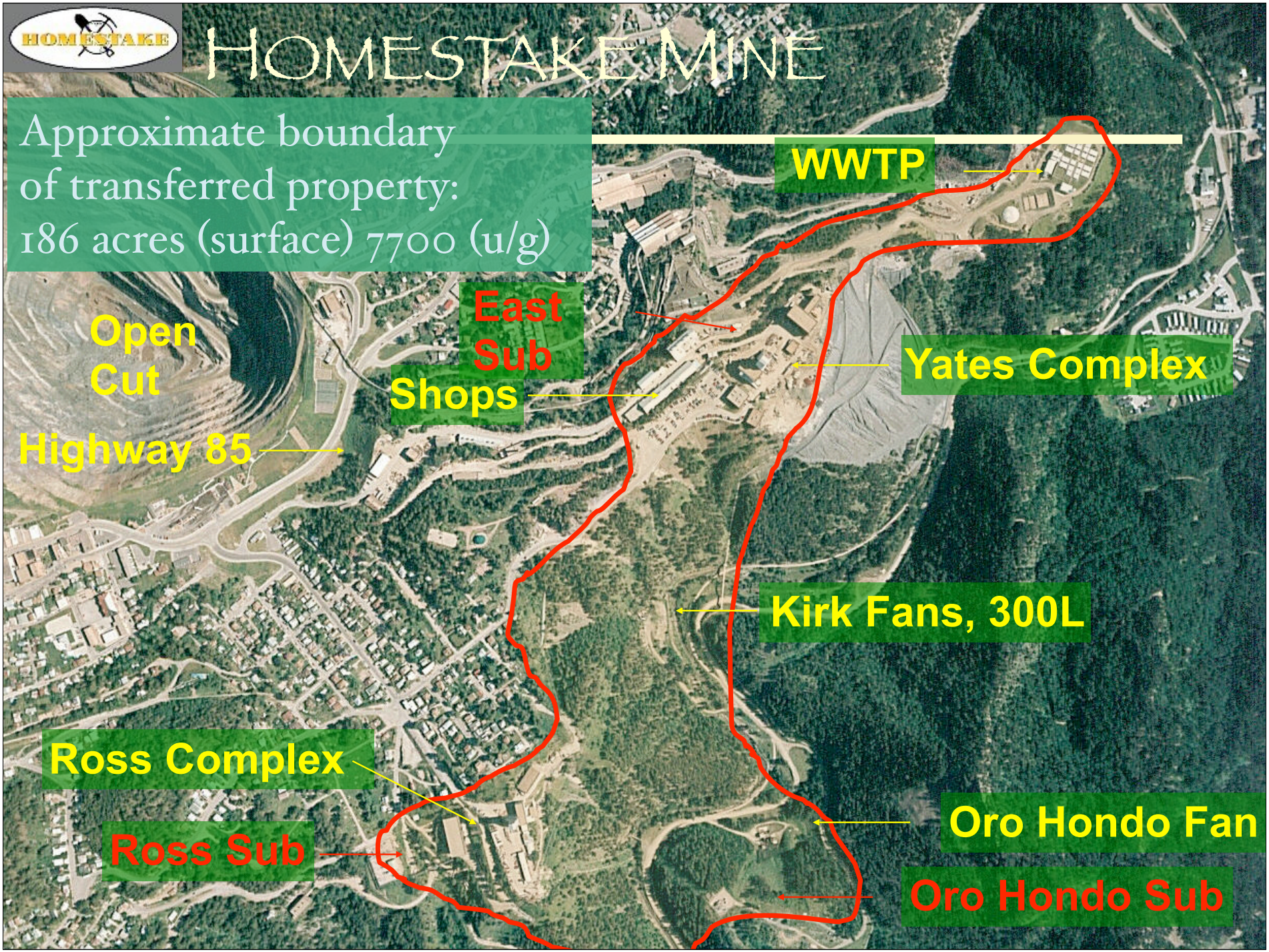


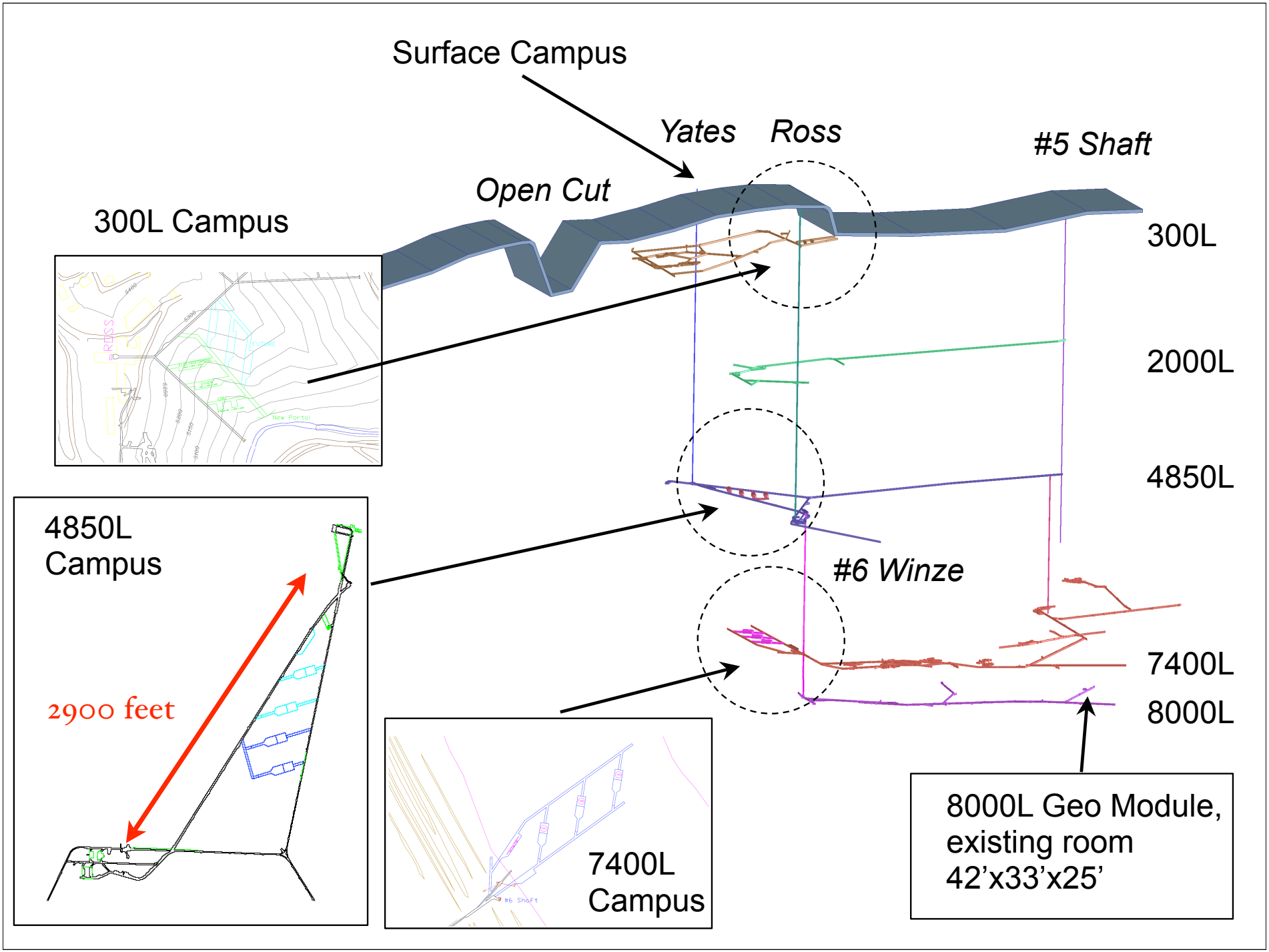


schedule is being updated to new NSF guidance

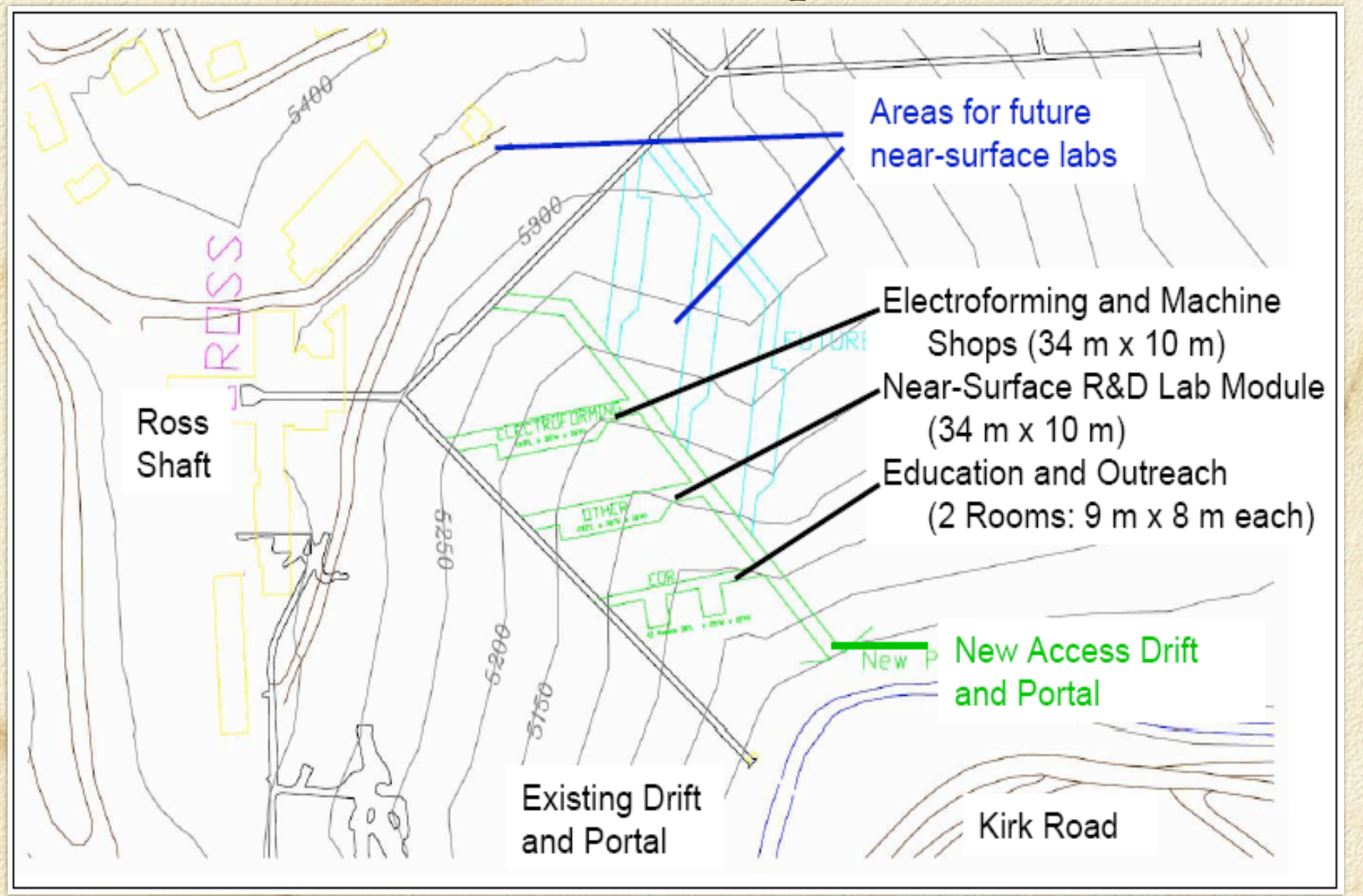
Phased approach to building DUSEL at Homestake




HOMESTAKE MINE
Approximate boundary
of transferred property:
186 acres (surface) 7700 (u/g)
WWTP
East
Sub
Shops
Yates Complex
Open
Cut
Highway 85
Kirk Fans, 300L
Ross Complex
Ross Sub
Oro Hondo Fan
Oro Hondo Sub

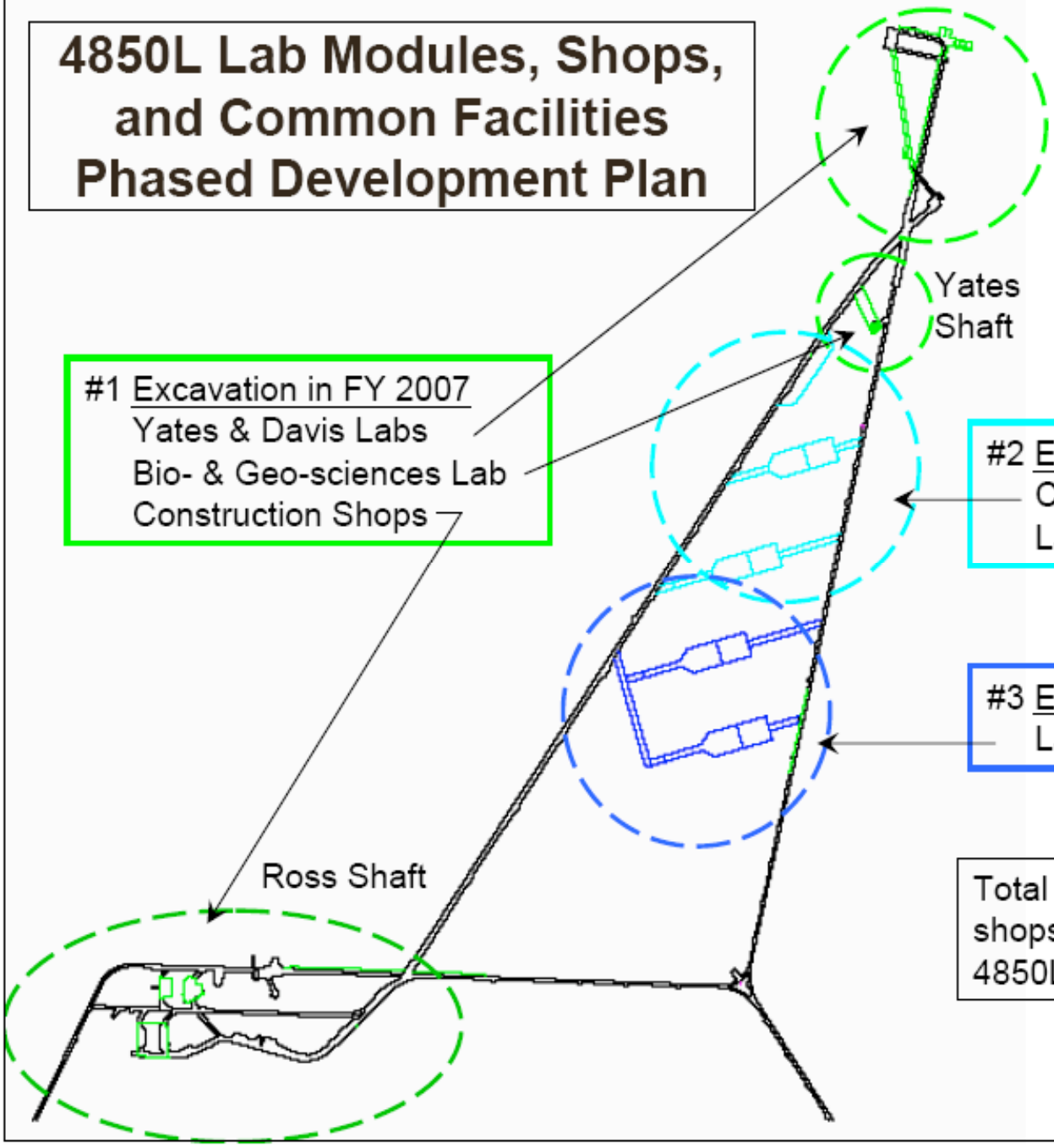

Surface Campus
Yates
Ross
#5 Shaft
Open Cut
300L Campus
300L
2000L
4850L
4850L Campus
2900 feet
#6 Winze
7400L
8000L
7400L Campus
8000L Geo Module, existing room 42'x33'x25'

300L Campus



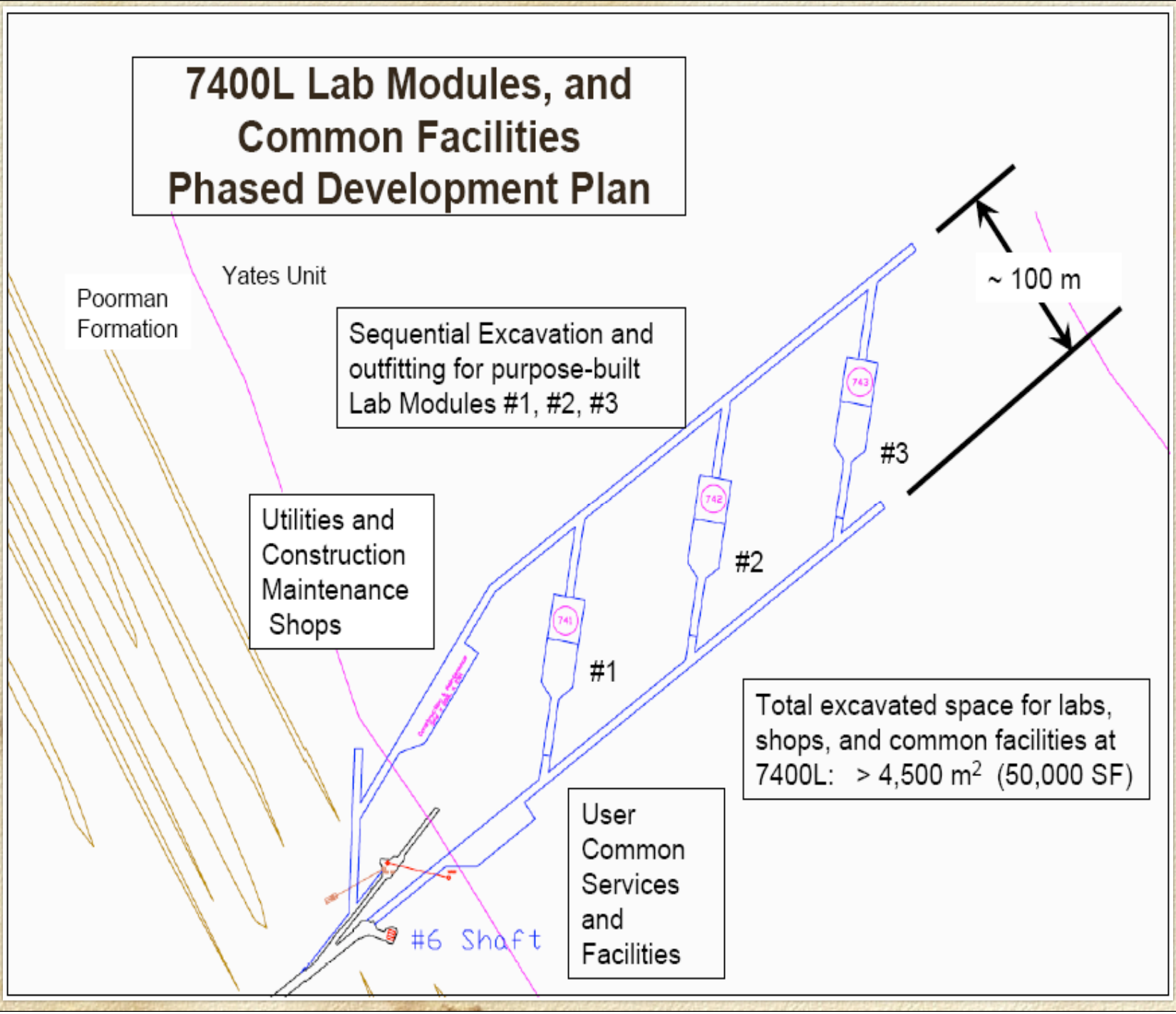
900 m² Drive-in access

4850L Lab Modules, Shops, and Common Facilities Phased Development Plan



Existing Neutrino Chamber: Davis Experiment 56' x 30' x 26'

7400L Lab Modules, and Common Facilities Phased Development Plan



Early Implementation Program

Homestake DUSEL Initial Suite of Experiments

	ReEntry CY 2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
				4850L and Above			**Deep Homestake & Expanded 4850L**			
Common Infrastructure										
Surface and Underground Laboratory Modules and Support Services	Title, Insurance, Indemnification, Rehab. Plans									
Surface Support Facilities Phase I	Phase I Rehab Existing Buildings									
Surface Support Facilities Phase II				Phase II Expansion						
300L	Rehab U/G	Prepare 300L								
4850L	Rehab U/G	Rehab U/G	Prepare 4850L							
7400L + 8000L					Rehab Deep U/G	Prepare Deep Labs				
Ultralow Background Materials Manufacture and Storage		300L Outfit / Production	300L Operation							
Well shielded "Water Room" for Assay and Experiments			4850L Outfit	4850L Operation						
Low Background Counting		300L Outfit / Production	300L Operation							
			4850L Outfit	4850L Operation						
Education and Outreach										
	Surface									
		300L Outfit / Production	**300L Operation**							
				4850L Outfit	**4850L Operation**					
						7400L Outfit	**Deep Modules Operation**			
Physics										
Dark Matter										
XENON		300L Outfit R&D	R&D and Lab outfit	4850L Deployment	Continued 4850L Operation		Continued or Deep Labs			
ZEPLIN		At Boulby		R&D Potential		Potential Deployment	Potential Deep Deployment			
miniCLEAN		300L Outfit R&D	R&D and Lab outfit	4850L Deployment			Deep Homestake (plus solar neutrinos)			
DRIFT		At Boulby			R&D Potential		Potential Homestake Deployment			
TPC		300L Outfit	R&D	R&D	R&D then Expt @4850L		Continued or Deep Labs			
SIGN		300L Outfit	R&D	4850L Deployment			Continued or Deep Labs			
SuperCDMS						Potential Deployment	Deep Deployment			
Neutrinoless Double Beta Decay										
Majorana		300L Outfit and Storage	R&D and Lab outfit	4850L Deployment	Operate 1st Phase Majorana		Outfit Deep Lab	MJ at Deep Homestake with add'l Mass		
EXO			*R&D EXO200 @ WIPP*		EXO 4850L		Continued or Deep Labs			
Long Baseline Neutrinos + PDK										
Large Cavity Geotechnical Studies, Siting		Cavity Geotechnical Studies,		Design	Cavity Construction 100kT Module(s)				Long Baseline Neutrino Program	
Lar, HSD & Water Cerenkov Detector R&D		300L Outfitting	R&D Program		300L R&D		300L R&D			
					4850L R&D		4850L R&D			
Solar Neutrinos										
LENS R&D		300L Outfitting	R&D Program				Advanced R&D			
				R&D	4850L Deployment		Continued or Deep Homestake			
Other Science										
Nuclear Astrophysics					Nuclear Astrophysics Program at 4850L					
Cloud Physics		Collaboration & Proposal Development					Potential Vertical Shaft Experiment			
Neutron-Antineutron Oscillations		Engineering & Feasibility Studies					Potential Vertical Shaft Experiment			
Long Baseline Gravity Wave		Engineering & Feasibility Studies							Possible Deployment	

Joint Physics & Earth Science Research				
Geoneutrinos Carbon Sequestration Geothermal Energy		R&D	4850L Deployment 4850L and Above Deployment	
Diural Earth Rotation		Collaboration & Proposal Development	R&D	Potential Vertical Shaft Experiment
Subsurface Geoscience				
Extant Information and DB	Database + Core	Database + Core	Database + Core	Database + Core
Geology and Rock Mechanics	Inspections	Surveys, Monitoring, Inspections	4850L Initial Experiments Followed by Large Block Experiments	Continued and Deep Homestake
Hydrogeology	Inspections	Surveys, Monitoring, Inspections	4850L Initial Experiments Followed by Large Block Experiments	Continued and Deep Homestake
Coupled Processes	Inspections	Surveys, Monitoring, Inspections	4850L Initial Experiments Followed by Large Block Experiments	Continued and Deep Homestake
Subsurface Engineering				
Geotechnical Studies	Inspections	Geotechnical Studies, Coring	4850L and above	Continued anc Continued and Deep Homestake
General Underground Construction	Inspections	Geotechnical Studies, Coring	4850L and above	Continued anc Continued and Deep Homestake
Geobiology				
Geomicrobiology	Inspections	4850L Drill Station and Shared U/G Lab		Deep (8000L) Drill Station
Geochemistry	Inspections	Surveys, Monitoring, Inspections	4850L and above	Continued and Deep Homestake
Biological Effects	Inspections	Surveys, Monitoring, Inspections	4850L and above	Continued and Deep Homestake
Ecology & Environmental Studies	Inspections	Surveys, Monitoring, Inspections	4850L and above	Continued and Deep Homestake

Perishable Information

Rock Mechanics/Hydrology/Coupled Processes/Engineering Large Scale Experiments

Geomicrobiology/ecology/biology/geochemistry Modules and Field Work, in situ work

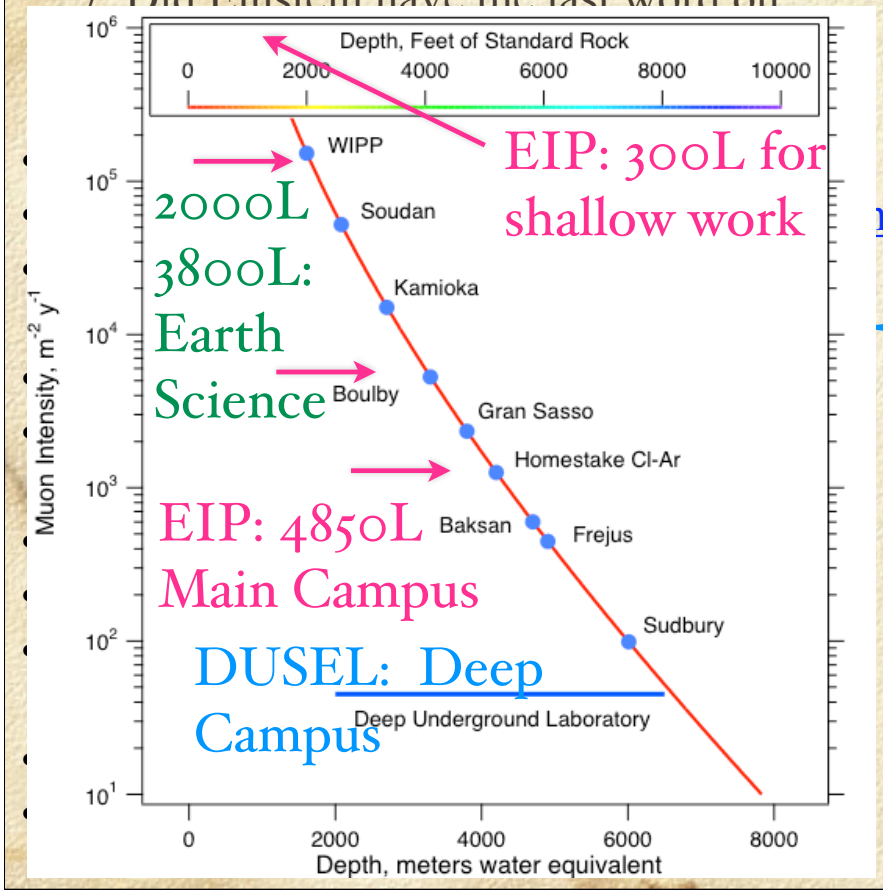
Surface 300L 4850L and above 7400L and 8000L 4850L and/or Deeper Levels Vertical Shaft	Underlined Experiments or Topics received specific PAC EIP Recommendations	Dates are approximate start dates for experiment and program deployments, they are representative of benefitial occupancy or other milestones. The detailed schedule and PAC recommendations should be consulted for specific information.

Homestake is Converting LOIs into MOUs

- To obtain specifics from collaborations for infrastructure needs and facility requirements
- Provide infrastructure as required by experiments and uses
- Satisfy the SDSTA and Sanford's requirement in defining the occupants

Physics Programs at Homestake

- National Academy **Quarks to Cosmos**
  1. What is the Dark Matter?
  2. What are the masses of the Neutrinos, ...?
  5. Are Protons unstable?
  7. Did Einstein have the last word on

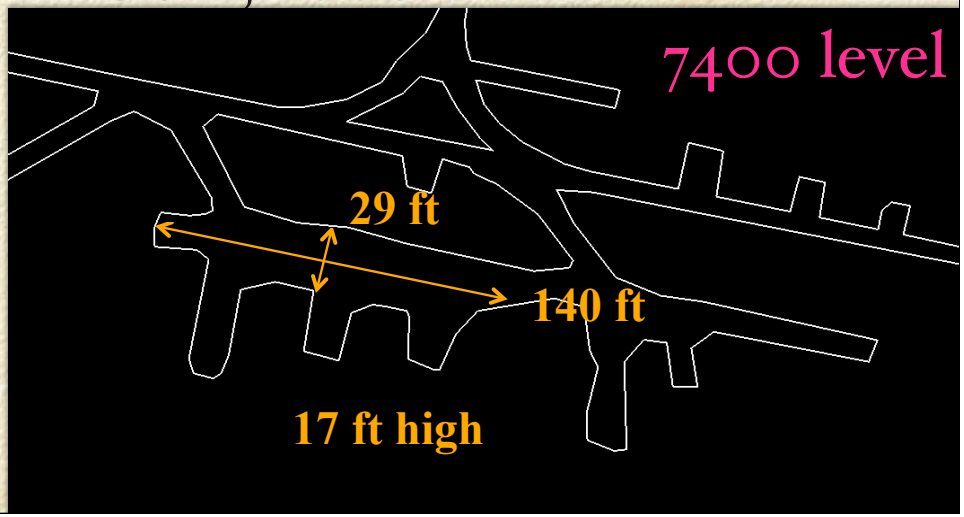


- Dark Matter
- Neutrinoless Double Beta Decay
  - ν mass
  - mass hierarchy
  - Dirac vs Majorana
- Solar Neutrinos
  - tests of oscillations, solar physics
  - sterile ν
  - MNSP matrix (12 and 13)
- Geoneutrinos
  - supernovae ν
  - p-e-p solar ν
- Long Baseline Neutrinos
  - CP violation
  - Mass hierarchy
  - MNSP Matrix elements (13)
  - atmospheric ν, MNSP Matrix (23)
- Nucleon Decay
- Nuclear Astrophysics
- Others
  - n-nbar (requires vertical shaft)
  - cloud physics (requires vertical shaft)
  - gravity wave experiments (requires long drift)

Large Cavities, Homestake & Long BaseLine Neutrino Programs

Existing Studies on Large Room Stability, Evaluations at Homestake, Existence Proofs

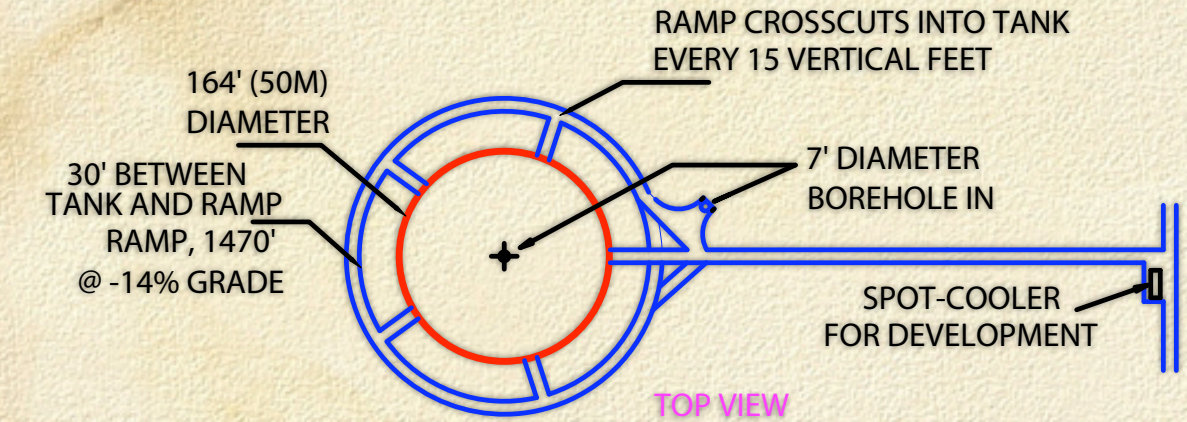
- Vertical Crater Retreat (45-61 m high) evaluations, Pariseau *et al.*, BOM, 1985
- 61 m dia. x 122 m cylinders, stable at 4850 and 6800, might not at 8000, Johnson and Tesarik, NIOSH, 2000
- Linear arrays of 50 m dia. x 50 m cylinders with 100 m spacing are stable at 4850, Callahan *et al.*, RESPECT, 2001

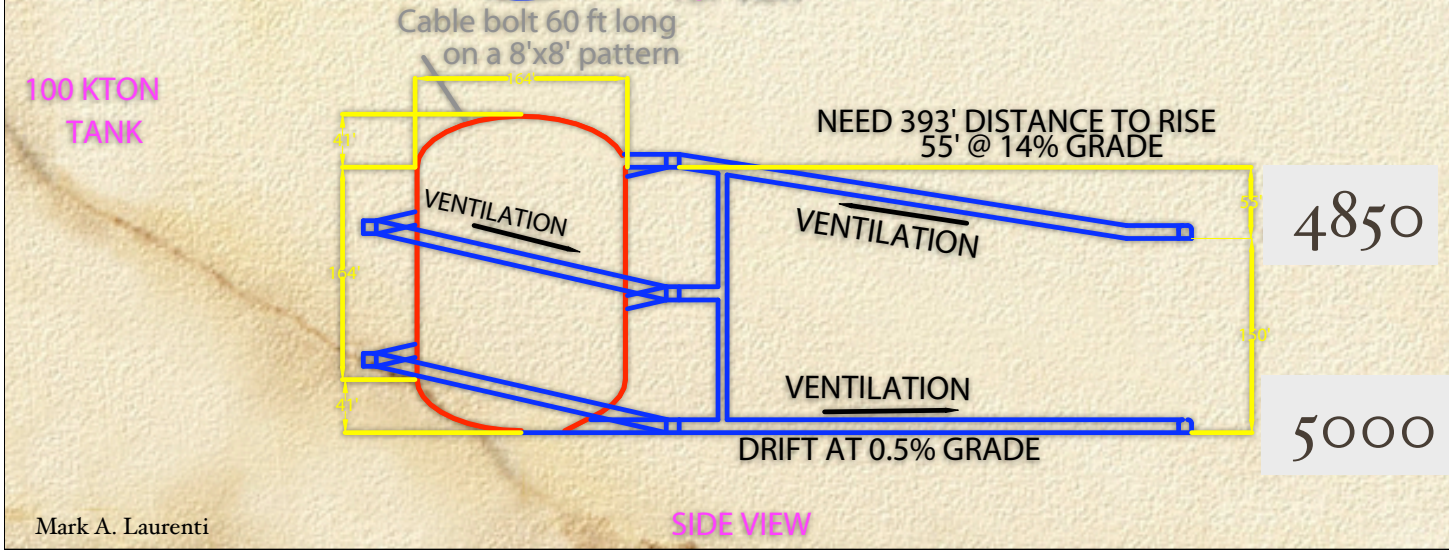


Megaton Modular Multi-Purpose 100kT Neutrino Detector

Construction Methodology

(this is one concept, not the only method)





Rock removal would be from the 5000 level, below the main operations

Summary: Homestake EIP & DUSEL

oad

vels

ce

TDR)

- Anticipate down-select Fall 20XX, Proceeding with EIP

Homestake PIs, Senior Personnel & Coordinators

- Michael Barnett, LBNL (E+O)
- Yuen-dat Chan, LBNL (Other uses)
- Milind Diwan, BNL (lbl, pdk)
- Reyco Henning, LBNL (ονdbd, dm)
- Ken Lande, Penn (lbl, pdk, geo-neutrinos)
- Bob Lanou, Brown (neutrinos, solar neutrinos)
- Chris Laughton, FNAL (engineering)
- Kevin T. Lesko, UCB (physics) PI
- Stu Loken, LBNL (E+O)
- Hitoshi Murayama, UCB (physics theory, neutrinos)
- Tommy Phelps, ORNL (geomicro)
- Bill Roggenthen, SDSM&T (geophysics) coPI
- Ben Sayler, BHSU (E+O)
- Tom Shutt, Case Western (low backgrounds)
- Nikolai Tolich, LBNL (geonus)
- Bruce Vogelaar, Virginia Tech (solar nus)
- Herb Wang, U Wisc. (geology, rock mechanics)
- Joe Wang, LBNL (earth science, geophysics)

Richard DiGennaro, LBNL, Project Manager and Systems Engineer

Liz Exter, Denis Peterson, LBNL Project control

Mark Laurenti, Mining Engineer

Syd DeVries, Mining Engineer

Dave Snyder, SDSTA Exec. Director

Trudy Severson, SDSTA

SDSTA Engineering and Safety Personnel

Ms. Melissa Barclay & Jeanne Miller

http://www.lbl.gov/nsd/homestake

http://neutrino.lbl.gov/Homestake/LOI

http://neutrino.lbl.gov/Homestake/FebWS

http://neutrino.lbl.gov/Homestake

http://homestake.sdsmt.edu/HRB/Refer.htm

http://www.dusel.org

KTLesko@lbl.gov